STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
STATE GEOLOGICAL SURVEY DIVISION
Morris M. Leighton, Chief

WATERLOO AREA

Monroe County

Waterloo Quadrangle

GUIDE LEAFLET 50F

by
Gilbert O. Raasch

Urbana, Illinois
November 4, 1950

ITINERARY

0.0	(0.0)	Caravan assembles, headed south, in parking area in front of Waterloo High School.
0.0	(0.0)	Turn right (W).
0.1	(0.1)	Stop sign. Turn right (N) on Route 3.
2.0	(2.0)	STOP No. 1. Upland Topography.

Although this area was glaciated by the Illinoian Glacier, the topography is controlled largely by the bedrock formations which underlie the glacial deposits. This topography has been somewhat subdued and modified by a thin covering of glacial till and a thicker covering of wind-deposited loess.

The Mississippi River trench which can be seen in the distance to the west was widened and deepened during and after the time of Illinoian glaciation. Accordingly its local tributaries were also able to deepen and extend their valleys; as a result, these streams have carved deep ravines, cutting well below the old upland surface.

5.3	(7.3)	Caution. Intersection with Route 158 in ravine. Go left (NW) on Route 3. Ledges of Mississippian bedrock on left along stream.
0.5	(7.8)	Enter COLUMBIA. Continue through on Route 3. Columbia Quarry, a very large operation tunneling massive beds of St. Louis limestone, lies 1 mile east.
1.5	(9.3)	Leave Columbia, on Route 3.
1.8	(11.1)	Intersection with Jefferson Barracks Bridge highway. Continue ahead (N) on Route 3.
1.7	(12.8)	Caution. Railroad crossing.
0.1	(12.9)	Turn right (E) on blacktop road up Cement Hollow.
0.3	(13.2	STOP No. 2. DUPO ANTICLINE and OIL FIELD.

Walk east one-half mile on Cement Hollow road.

Ledges of Mississippian (Ste. Genevieve) limestone exposed along creek show steep westerly dip.

0.3 miles farther east pumping wells of the Dupo oil field may be seen.

A short distance beyond, the ledges of Mississippi (Salem) limestone along the creek are horizontal and a few hundred yards still further they are inclined gently to the east.

ROCK STRUCTURE AND OIL ACCUMULATION.

These changes in the attitude of the limestone layers are the result of a sharp upfold (anticline) in the bedrock strata. This fold averages about a mile wide and runs from St. Louis south beyond Waterloo. Its date of formation is not definitely known but took place at some time during the long interval between the Coal Period (Pennsylvanian) and the Ice Age (Pleistocene). Later the creek cut its valley down into the bedrock and revealed this cross-section of the anticline.

Oil is lighter than salt water. In porous rock layers underground, the oil slowly separates from the water and then migrates to the highest places in the porous stratum, just as cream seeks the highest place in a bottle of milk. For this reason, the oil in time rises into the crests of folds or domes to form "oil pools." Such pools are not cavernous openings but merely high places in a porous rock stratum.

The oil in the Dupo Field comes from a porous zone in Ordovician, Kimmswick (or "Trenton") limestone, which here lies about 600 feet below the surface. The pool was discovered in 1928 by studying the inclination of the strata, such as you see here.

Besides the wells here in Cement Hollow, others are located on top of the bluff to the north, and others lie on the Mississippi flats to north west. Thus, the present topography of hills, and valleys has no relation to the location of oil pools, which depend entirely on high and low places in the bed rock (bedrock structure).

(See diagram in appendix.)

MISSISSIPPIAN BED ROCK.

The lowest (oldest) rock shown in Cement Hollow belongs to the Keokuk Formation. It is granular limestone made up largely of ground-up shells, crinoidal remains, and corals. Fossils are abundant and include many types of brachiopods, bryozoa (moss animals), cup corals, and trilobite heads and tails. Most abundant is the brachiopod *Spirifer washingtonensis* Weller. These ledges are present in the creek bed at the east end of the outcrop.

Just above them in the creek are some layers of dull gray shaly limestone, fine grained and unfossiliferous. These belong to the Warsaw formation, here thin, which is elsewhere famous for its crystal-lined geodes.

The Warsaw Formation grades upward into a yellowish porous, granular limestone, the Salem formation, here somewhat resembling the famous building stone, the Indiana Limestone. It is this same Salem formation which in Indiana supplies this valuable building stone.

Farther up the hollow at a higher elevation, the road passes outcrops of gray, massive, dense St. Louis Limestone, which lies above the Warsaw. Highest Mississippian formation in the region is the St. Genevieve Limestone which lies above the St. Louis. It is present at the west end of the belt of outcrops as a result of folding which has dropped it to a low elevation along the west edge of the Dupo (or Waterloo) Anticline.

All of these formations were deposited on the floors of ancient seas which invaded the interior of the continent in Mississippian Time.

0.0 (13.2) Continue ahead along main blacktop road which winds northeastward out of Cement Hollow.

2.2 (15.4) STOP No. 3. Among sink holes at top of grade.

For the next mile & a half, the route lies between a network of small sink holes. Wherever the St. Louis and Ste. Genevieve limestones come close to the surface, this sink hold topography develops. The pure limestones are readily dissolved by surface waters which sink underground and flow along joints (fracture systems) in the rock. The dissolving action of the water widens these joints so that in time the overlying earth falls into the crevices, leaving sink holes at the surface. Some sink holes also are caused by the collapse of the roofs of caverns that have been dissolved out of the limestone.

In time, the network of enlarged crevices and sink holes becomes so extensive that streams sink below the surface and flow underground. Note that few surface streams cross the sinkhole belts shown on the topographic map.

1.6 (17.0) Stop sign. Turn left (N).

1.0 (18.0) Standard School (check point).

1.4 (19.0 Y-intersection, go left. (N).

0.2 (19.2) Stop sign. Go left (W). Road has descended to flood plain of Mississippi River, here five miles wide. This is an alluvial plain built of Mississippi river sands and gravels washed down the great river in Pleistocene and recent times. Except for the man-made levees, such as that on the right, the flood plain has a very flat topography. It is here five miles wide with the river at present flowing along the Missouri side.

Quarries in river bluffs to left are largely in the St. Louis Limestone.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

0.4 (19.6) Turn left (E) into road to East St. Louis Stone Company Quarry.

0.2 (19.8) STOP No. 4. At base of road ascending bluff. Walk up road to top of quarry.

Above the bedrock forming the quarry rime, stripping operations to remove the earthy overburden are in progress.

The vertical cliff of earth consists of loess, with patches of glacial till present in the floor of the excavation. Beneath the till, in crevices going into the bedrock are patches of fine, crumbly red clay.

The red clay dates from before the Ice Age and is the insoluble residue left behind by the weathering of the limestone. This clay once covered all of the bedrock surface, but was largely scraped away by the Illinoian ice sheet.

When the ice sheet melted away, any earth or stones that had become incorporated in the glacial ice during its long journey from northeast Canada was left behind. This residue from the melted ice, forming a thin blanket of earth over the surface of the region, is called glacial till. It is an unsorted mass of clay, sand, and pebbles.

During the long interval of time after the melting of the Illinoian ice sheet, rain waters, seeping downward through the till blanket, dissolved out the lime and oxidized the iron content to a buff or a red color. Many types of pebbles such as granite, gneiss, and gabbro were weathered away, and only very resistent rocks such as quartz, chert, quartzite, basalt, and greenstone still remain. Deeply weathered glacial till such as this is called gumbo-till.

The Wisconsin Glacier which followed the Illinoian after a period of some 150,000 years did not reach this part of Illinois. But the waters from its melting, choked with sediment, poured down the Mississippi river, where great sand and mud flats developed. The westerly winds, blowing across the flats, picked up the clay and silt and dropped most of it over the bluffs and upland to the east. Such upland deposits of dust are called "loess," which can stand in massive, vertical banks because of the tight packing of the very angular particles.

As in the till, the descending rain waters dissolved the lime from the upper part of this thick loess deposit. The downward movement of the waters was largely stopped when the impervious gumbo till under the loess was reached. Hence, the lime dissolved above was again deposited in the lower part of the loess, as rounded aggregations of an ashy color. Some of these assume fanciful shapes called "loess kindchen," i.e. "little children."

Descend bluff and go south past quarry.

1.0 (20.8) STOP No. 5. FALLING SPRINGS PARK.

Walk east to Falling Springs. Here, where a large stream of water gushes from the mouth of a cavern, we see the opposite end of the underground drainage system the beginnings of which we saw in the sinkhole network at STOP No. 3. There a cavern and crevice system carrying waters from the upland region to the east has been cut open by the development of the Mississippi River trough. Thus the underground stream is forced to cascade down the bluff into the open.

Walk north, past numerous cavern openings to old quarry in St. Louis and Ste. Genevieve limestones.

Approximately the lower 50 feet of limestone in this quarry belongs to the St. Louis Formation. The layers are thicker and the rock denser below, with one thick buff layer conspicuous among the light gray strata. The higher St. Louis strata are thinner and more distinct, and separated by shale laminae. The surfaces of some of these upper layers are covered with fronds of bryozoa, others have crinoid heads and the spines of sea urchins.

Some of the St. Louis limestone layers have been shattered and recemented, probably while the layers still lay beneath the waters of the Mississippian sea. Another conspicuous feature of the rock is the occurrence of stylolites-vertical flutings in the rock. These probably developed as a result of solution under pressure, possibly at a time when the sediment was not yet completely solidified.

The upper 30 feet of limestone belongs to the Ste. Genevieve formation, characterized by coarser grain and oolitic texture. (Oolites are tiny spherical aggregations of lime carbonate with a concentric structure, like the layers of an onion). The Ste. Genevieve beds are commonly cross-bedded and probably originated as a lime sand.

Near the base of the St. Genevieve are shaly layers full of pebble-like masses of fossil algae. Immediately below these is a very coarsely granular limestone with cross-sections of gastropods (snails).

Above the Ste. Genevieve is a thick overburden of Pleistocene loess.

0.0 (20.8) LUNCH STOP in FALLING SPRINGS PARK.

0.0 (20.8) Reverse route and go northwest on McBride road.

1.2 (22.0) Stop sign. Turn left (SW).

0.1 (22.1) DANGER. Railroad crossing.

0.2 (22.3) Turn left, then half-right on streets in PRAIRIE DU PONT.
STOP SIGN. Turn left (SE) on Route 3.

0.2 (22.5) Caution. Railroad crossing. DUPO.

2.7 (25.2 Leave DUPO.

0.5 (25.7) Note derricks of Dupo Field on flat to east; steep southwest dip of Dupo Anticline shows in Sugar Loaf Bluff to southeast.

0.3 (26.0) Turn left (E) on Cement Hollow Road and repass outcrops of Stop No. 2.

1.0 (27.0) Forks. Continue ahead (E) in Cement Hollow.

1.9 (28.9) Stop sign. Turn right (S).

0.9 (29.8) BLUFFSIDE. Continue ahead (E).

0.1 (29.9) Turn right (S) with blacktop.

3.5 (33.4) Stop sign. Turn left (E) on Route 158.

2.3 (35.7) Caution. Railroad crossing.

0.3 (36.0) Enter MILLSTADT.

0.5 (36.5) Stop sign in Millstadt. Turn left (N).

1.4 (37.9) Turn right (E) into Midwest Coal Company mine.

0.6 (38.5) Office of Midwest Coal Company.

STOP No. 6. Strip mine in Coal No. 6 (Herrin Coal). Officials of Midwest Coal Company will guide trip to strip mines.

The pit shows a typical succession of Illinois coal strata with underclay present in the pit floor, upon which rests about 5 feet of coal, generally overlain by "roof slate." This black slaty shale contains conodents, small circular brachiopods (Orbiculoidea) and fish scales. (Conodonts are microscopic, sawlike teeth of unknown origin). Above the roof slate is a zone of rock which varies from place to place along the pit face. In places it is nearly all limestone, in others gray or yellow shale. Marine fossils are present, most commonly brachiopods and crinoid joints.

The different kinds of rock layers associated with the coal reflect the changing environments of the time and region. Sometimes the area was a great delta region of rivers and sloughs, sometimes it was occupied by vast coastal swamps, and sometimes it lay under the salt water of the sea. The underclay is thought by many to be the soil in which the coal swamp forests grew--the coal to be the result of accumulations of decaying vegetation in the great swamps--the roof slate to have been deposited in stagnant

lagoons connected with sea--the limestone and shale to have been deposited in the waters of the open sea--sandstones as well as shales containing land plants (not seen in the pit outcrop) record river, delta, and flood plain environments that stood for a time, a little above sea level. Then the land would sink again and the great coastal swamps, and finally the sea, return. In this way the thousands of feet of coal-bearing strata in Illinois were laid down. Here most of this thickness of strata has been removed by later erosion. Farther west, as seen earlier on the trip, this erosion has cut entirely through the coal-bearing strata into the Mississippian limestones which underlie them everywhere.

0.0 (38.5) Reverse route to Millstadt.

2.3 (40.8) Stop sign in MILLSTADT. Cross Route 158 and continue ahead (S).

0.9 (41.7) Forks. Go left on Floraville Road.

1.0 (42.7) Strip mine on right.

4.7 (47.4) FLORAVILLE (on right).

1.4 (48.8) PADERBORN.

3.0 (51.8) Stop sign. Go right (S) on Route 159.

2.1 (53.9) Highway intersection. Turn left (E) on Route 156.

0.8 (54.7) Park opposite entrance to quarry, and walk north to quarry.
STOP NO. 7. CHESTER LIMESTONE.

After the deposition of the thick St. Louis-Ste. Genevieve limestone, conditions of the crust in southern Illinois became more unstable so that only at times was the sea present, while alternately land conditions prevailed. Thus marine limestone and shale formations alternate with sandstone and shale formations of non-marine origin. This succession of limestone, sandstone and shale accumulated to a thickness of many hundreds of feet and is called the Chester Group.

The Okaw limestone seen in the quarry belongs to this group. Like many Chester limestones, it teams with fossils, including many lacy bryozoa and the cork-screw Archimedes, as well as brachiopod shells crinoidal fragments, pentremites, and cup corals. It is underlain by shale.

In the Waterloo area, the Chester beds are thin because most of the strata were worn away by erosion before the deposition of the Pennsylvanian coal-bearing formations. These latter also have since been worn away from this spot.

END OF CONFERENCE.

GENERALIZED GEOLOGIC COLUMN FOR THE WATERLOO AREA

Prepared by the Illinois State Geological Survey

ERAS			PERIODS	EPOCHS	FORMATIONS
Cenozoic	"Recent Life"	(Age of Mammals)	Quaternary	Pleistocene	*Recent post-glacial stage *Wisconsin glacial stage *Sangamon interglacial stage *Illinoian glacial stage Yarmouth interglacial stage Kansan glacial stage Aftonian interglacial st. Nebraskan glacial stage
			Tertiary	Pliocene Miocene Oligocene Eocene	Not present in Waterloo Area.
Mesozoic	"Middle Life"	Age of Reptiles	Cretaceous		Present in extreme southern Illinois only
			Jurassic		Not present in Illinois
			Triassic		Not present in Illinois
Paleozoic	"Ancient Life"	Age of Amphibians and early plants	Permian		Not present in Illinois
			Pennsylvanian		*Including Herrin (No. 6) Coal and associated beds at Midwest Mine
			Mississippian	Upper (Chester)	*including Okaw Limestone
				Lower	*St. Genevieve ls. *St. Louis ls. *Salem-Warsaw ls. *Keokuk ls.
		Age of Fishes	Devonian		Not present in Waterloo Area.
		Age of Invertebrates	Silurian	Niagaran Alexandrian	Dolomite in deep wells
			Ordovician		Over 1,500' of strata.
			Cambrian		No data
oterozoic cheozoic			Referred to as "Pre-Cambrian" time.		No data

*Deposits exposed in Waterloo Area

GEOLOGICAL HISTORY OF THE WATERLOO AREA

BEDROCK FORMATIONS.

The bedrock which crops out in the western and southern parts of the Waterloo area is largely of Mississippian age, but in the northeast, these rock layers are covered by younger strata belonging to the Pennsylvanian, or Coal Period. Deep wells drilled for oil or water encountered still older strata of Silurian and Ordovician age, deposited for the most part, like the Mississippian strata in ancient seas that invaded the interior of the continent.

Deeper wells at St. Louis and in Jersey County encounter still older rocks below the Ordovician strata. These are marine limestone and sandstone of Cambrian age, bearing the oldest clearly differentiable fossils. Evidence from the St. Francis mountains of Missouri, where the older strata have been uplifted, as well as from the wells mentioned shows that the Cambrian formations lie upon still older rock masses. These oldest of rocks are largely granite and related crystalline rocks which once cooled from a molten state as the roots of mountain systems. Long before the coming of the Cambrian sea, these mountains were beveled away by erosion to expose the granite "basement" upon which the bedded rock layers of Illinois now rest.

MISSISSIPPIAN HISTORY.

The ancient lime-depositing seas persisted into Mississippian time and laid down Lower Mississippian limestone strata hundreds of feet thick. Later in Mississippian time the earth's crust in this region became somewhat unstable so that gentle rises and recessions of sea level caused an alternation of salt and fresh water conditions. When the seas advanced, limestones and marine shales full of the fossils of sea life were laid down. When the sea retreated, streams, lakes, and lagoons received deposits of fresh water shales and sandstones, sometimes entombing fragments of land plants.

Finally the land rose a sufficient height above the sea to suffer the attack of erosive forces, which cut away hundreds of feet of the recently deposited strata.

PENNSYLVANIAN HISTORY.

In the Pennsylvanian or Coal Period which followed, the land again began to sink gently, but seas only occasionally reached this region. Most of the shale and sandstone which makes up the bulk of the more than 2,000 feet of Pennsylvanian strata which accumulated in Illinois, thus was formed on land or in shallow fresh water.

At that time, in the vicinity of the present Atlantic Coast, high mountains were rising, that might be comparable to the present Andes. Between the mountains and the inland seas that lay off to the west from Nebraska down through Texas, there extended a hot and humid swampy plain crossed by rivers moving westward from the mountains to the sea. The region may be likened to the Amazon Basin which today stretches eastward from the foot of the Andes.

At times the sinking of the lowland permitted the sea to extend far to the east and deposit fossiliferous limestone and shale over Illinois. At other times vast jungle swamps accumulated dense vegetation, which, falling in the poisonous waters, was preserved from complete decay to form our valuable coal beds. But for the most part, the low land was occupied by rivers, shallow lakes, and bayous in which mud and sand, washed out from the mountains, came to rest to form shale and sandstone. The piling up of thousands of feet of this sediments helped to compress the peaty layers of vegetation into coal.

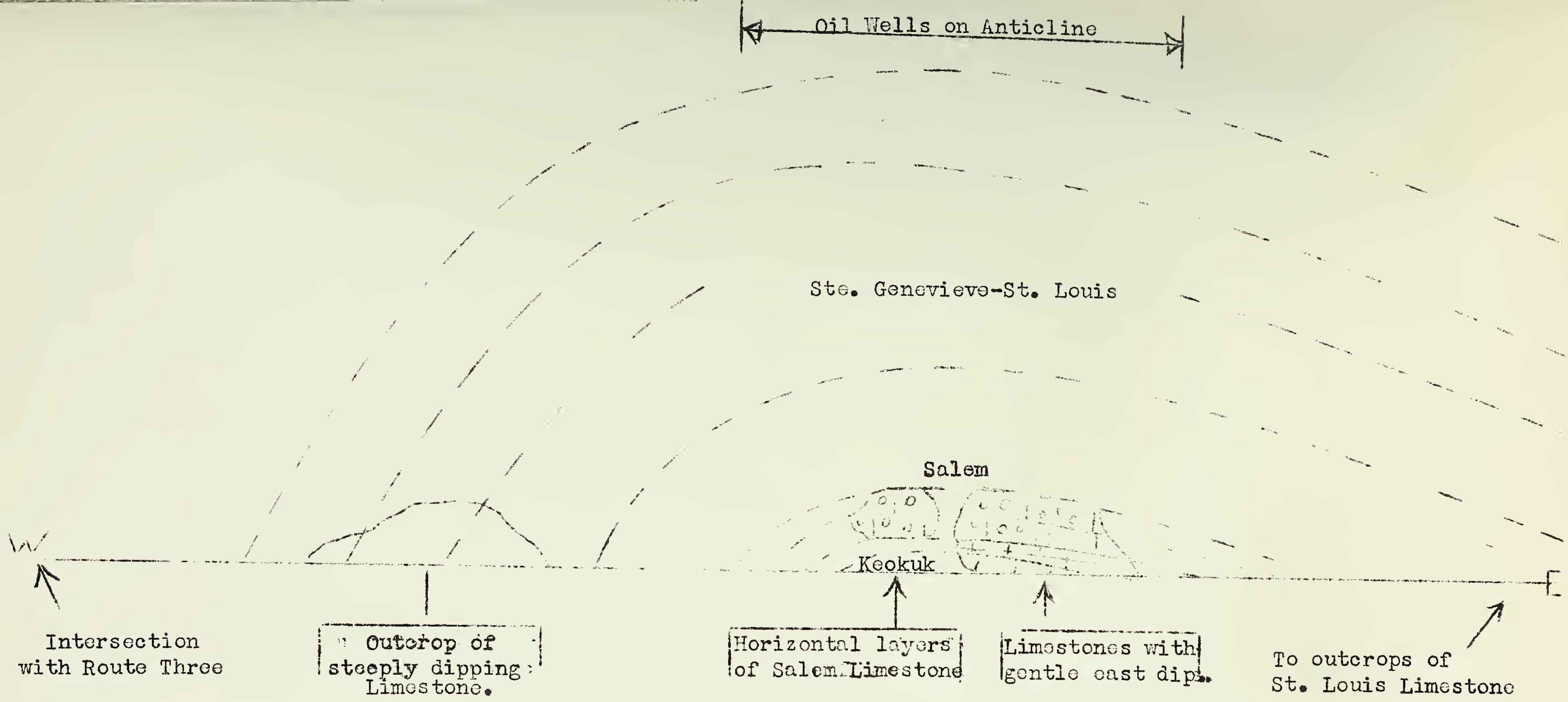
THE LOST INTERVAL.

Following Pennsylvanian time, the land rose to a moderate elevation above the sea and apparently was never again covered by marine waters. Under these conditions, erosion by streams and the weather slowly cut down the land, and in the Waterloo area in places cut away all of the Pennsylvanian formations down to the Waterloo rock. The disintegrated rock was carried away as sand, gravel, and mud by streams and rivers, to be deposited in areas remote from this region. Thus it is that we have no direct evidence of the life and environment here during the Age of Reptiles and the Age of Mammals that followed.

ICE AGE HISTORY.

The glaciers which relatively recently moved down into Illinois from the far north wrote the last chapter of the geologic history of the region. During the Pleistocene period (or Ice Age), glaciers invaded Illinois, not merely once, but four times, and each ice invasion was separated from the next by a long mild interval of 100 to 300 thousand years. During these mild intervals plant and animal life returned, soils formed, and conditions were not greatly different from what they are today. In fact, there is no way of knowing but what we are living today in just such an interval that will be terminated a few hundred thousand years hence by a fifth ice advance.

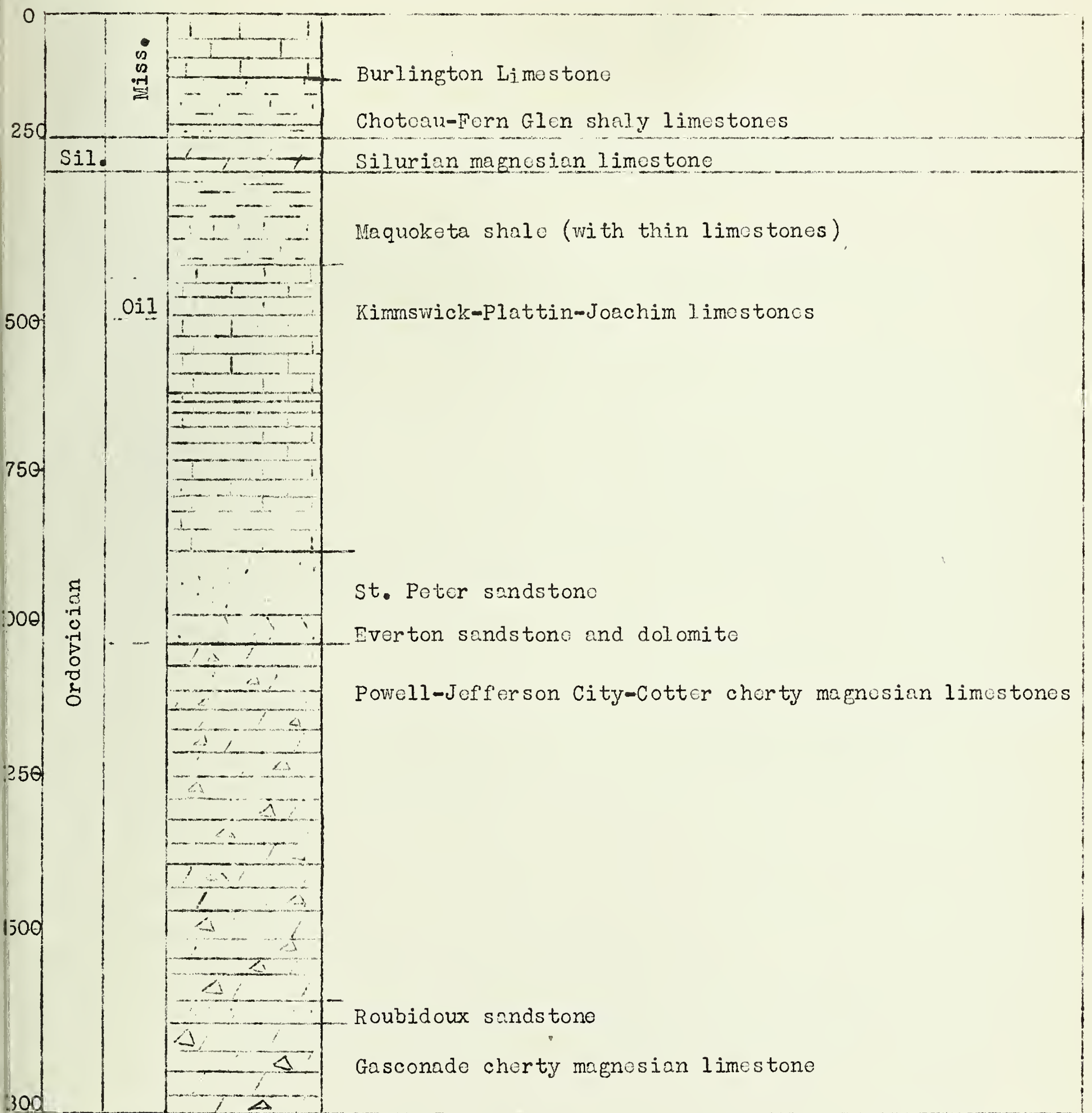
Only one of the glaciations, the third or Illinoian, reached the Waterloo region, but glacial conditions farther north effected the climate, geology, and topography in the Chester area, especially through the agency of the Mississippi. The great river carried the melt waters and the sediments from the wasting glaciers farther north, and was the source of the loess, blown from the river flats onto the uplands to the east.

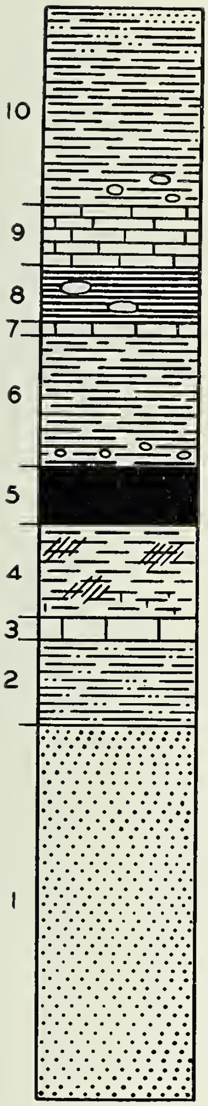


ROUGH DIAGRAM OF RELATIONS OF OUTCROPS
IN CEMENT HOLLOW
AND RELATION OF DUPO WELLS TO ANTICLINAL STRUCTURE.

DEEP WELL RECORD

Based largely on Tarlton-Dyroff test well, Dupo Oil Field, St. Clair County





Shale, gray, sandy at top; contains marine fossils and ironstone concretions especially in lower part.

Limestone; contains marine fossils.

Shale, black, hard, laminated; contains large spheroidal concretions ("Niggerheads") and marine fossils.

Limestone; contains marine fossils.

Shale, gray; pyritic nodules and ironstone concretions common at base; plant fossils locally common at base; marine fossils rare.

Coal; locally contains clay or shale partings.

Underclay, mostly medium to light gray except dark gray at top; upper part noncalcareous, lower part calcareous.

Limestone, argillaceous; occurs in nodules or discontinuous beds; usually nonfossiliferous.

Shale, gray, sandy.

Sandstone, fine-grained, micaceous, and siltstone, argillaceous; variable from massive to thin-bedded; usually with an uneven lower surface.

AN IDEALLY COMPLETE CYCLOTHEM

(Reprinted from Fig. 42, Bulletin No. 66, Geology and Mineral Resources of the Marseilles, Ottawa, and Streator Quadrangles, by H. B. Willman and J. Norman Payne)